

# PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventor: MICHAEL JOSEPH FRENCH

836,920



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International Classification:—F01d.

## COMPLETE SPECIFICATION

### Rotors for Multi-Stage Axial Flow Compressors or Turbines

We, D. NAPIER & SON LIMITED, a Company registered under the Laws of Great Britain, of 211, Acton Vale, London, W.3, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be described in and by the following statement:—

This invention relates to rotors for multi-stage axial flow compressors or turbines. For reasons of lightness and to facilitate manufacture, it is a common practice to build up such rotors from several sections which are fitted together end to end. In such rotors provision must be made for transmitting the drive from one section to the next, but if this is done by providing the sections with inter-engaging dogs or other inter-engaging formations difficulties arise in accurately controlling the parallelism and overall longitudinal dimension of the rotor.

According to the present invention a rotor for a multi-stage axial flow compressor or turbine comprises several sections having hollow cylindrical or frusto-conical portions with flat faces at the extreme ends thereof lying in parallel planes perpendicular to the rotational axis and which abut against the adjacent end faces of the adjacent sections, and dowels extending radially across the abutting end faces and fitting tightly in recesses in adjacent sections.

In such a rotor the length dimension of each section is easily controlled since it is a dimension between two parallel flat surfaces at the extreme ends of the sections. Being at the extreme ends, there are no overhanging or projecting portions to interfere with the passage of a grinding wheel or other finishing tool across these surfaces. Thus the said length dimension can be controlled with a high degree of accuracy obtainable by unobstructed grinding or lapping. Consequently, the overall length dimension of the rotor is accurately controllable.

The dowels transmit the drive from one section to the next. Preferably the dowels are made slightly oversize in relation to the recesses which are to accommodate them, and means are provided for holding the sections in axial compression. This ensures that the dowels will fit tightly in the recesses and will transmit the drive without any play. Moreover, the tight fit substantially reduces the risk of dowels coming adrift.

Preferably, the dowels have heads on their inner ends so that centrifugal force will not tend to dislodge them.

The invention may be performed in various ways and one form of rotor embodying the invention, for the axial flow compressor for an aircraft power unit, will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal sectional elevation of the rotor, partly broken away, and

Figure 2 is a perspective view of a dowel on a larger scale.

Referring to the drawings, the rotor is in the form of a cylindrical drum 10 with the rotor blades 11 mounted around the peripheries of annular flanges 12 extending from the cylindrical drum, the external diameters of these flanges increasing progressively from the inlet end of the rotor towards the outlet end, i.e. from left to right in Figure 1.

The rotor is built up from a plurality of sections. Each section has a cylindrical portion 14 adapted to abut against the cylindrical portions 14 of the adjacent sections on each side to constitute the cylindrical drum 10. Extending radially outwards from the centre of the cylindrical portion of each section is one of the said flanges 12. The outer periphery of each flange 12 is thickened in the axial direction at 15 and is provided with grooves to receive the roots of the rotor blades 11 which are to be mounted on this section. The two end sections 16 and 17 of the rotor are of somewhat different form, having dish

flanges 18 and 19 respectively, and being provided with cylindrical extensions 20 and 21 respectively which carry the inner races of bearings (not shown) upon which the rotor is mounted. The end sections of the rotor also carry air and oil seal devices in the conventional manner. A light tube 23 extends through the centre of the rotor between the two end sections 16 and 17 for a purpose to be described.

The cylindrical portions 14 of the sections have flat end faces lying in parallel planes perpendicular to the rotor axis, and which abut against the adjacent end faces of the cylindrical portions 14 of the adjacent sections when the rotor is assembled. Radial bores are formed through the cylindrical sections 14 such that half of each bore lies in one section and the opposite half lies in the adjacent section, that is to say, the planes of the abutting end faces of adjacent sections bisect the bores on a diameter. Cylindrical dowels 25 (see Figure 2) are inserted in these bores, the dowels having heads 26 at their inner ends. These heads are provided with diametral slots 27, and circlips 28 are inserted into the hollow interior of the rotor to engage the slots 27 to hold the dowels against inward movement towards the rotor axis. The heads 26 prevent outward movement of the dowels.

To form the said bores the sections are assembled together in a jig and the bores are drilled with a radial drill and reamed. The diameter of the bores is slightly smaller than the diameter of the dowels 25. The rotor is then dismantled and reassembled with the dowels in the bores. Owing to the dowels being slightly oversize, the end faces of the sections will be separated by slight gaps. The central tube 23 is then inserted hot and is tightened by screwing up a nut 29. As the tube 23 cools it shrinks and draws the two end sections 16 and 17 closer together, thereby

closing the said gaps and somewhat distorting the dowels 25 and adjacent parts of the cylindrical portions 14 to ensure that the dowels 25 are a tight fit.

The annular spaces 30 between the flanges 12 and the outer surface of the cylindrical drum portion 10 of the rotor are blanked off from the main flow passage 31 of the compressor by thin metal spring rings 32 which are engaged between the platform portions 33 of the rotor blades 11 in adjacent blade rings, the said platform portions 33 lying between the aerofoil portions and the root portions of the blades.

These spring rings may be dispensed with where the stator blade ring between two rotor blade rings is of shrouded form, that is to say if it has an annular member attached to the tips of the stator blades, since this annular member will also serve to blank off the said spaces from the main flow passage.

#### WHAT WE CLAIM IS:—

1. A rotor for a multi-stage axial flow compressor or turbine comprising several sections having hollow cylindrical or frusto-conical portions with flat faces at the extreme ends thereof lying in parallel planes perpendicular to the rotational axis and which abut against the adjacent end faces of the adjacent sections, and dowels extending radially across the abutting end faces and fitting tightly in recesses in adjacent sections.

2. A rotor as claimed in Claim 1 in which the dowels are slightly oversize in relation to the recesses which are to accommodate them, and means are provided for holding the sections in axial compression.

3. A rotor as claimed in Claim 1 or Claim 2 in which the dowels have heads on their inner ends.

4. A rotor substantially as described with reference to the accompanying drawings.

KILBURN & STRODE,  
Agents for the Applicants.

#### PROVISIONAL SPECIFICATION

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This invention relates to rotors for multi-stage axial flow compressors or turbines. For reasons of lightness and to facilitate manufacture, it is a common practice to build up such rotors from several sections which are fitted together end to end. In such rotors provision must be made for transmitting the drive from one section to the next, but if this is done by providing the sections with inter-engaging dogs or other inter-engaging formations difficulties arise in accurately controlling the overall longitudinal dimension of the rotor.

According to the present invention a rotor for a multi-stage axial flow compressor or turbine comprises several sections having hollow cylindrical or frusto-conical portions with flat end faces lying in parallel planes perpendicular to the rotational axis and which abut against the adjacent end faces of the adjacent sections, and dowels extending across the abutting end faces and fitting tightly in recesses in adjacent sections.

In such a rotor the length dimension of each section is easily controlled since it is a dimension between two parallel flat external surfaces. This dimension can be controlled with a high degree of accuracy in a conventional turning operation. Consequently, the overall length dimension of the rotor is accu-

rately controllable. The dowels transmit the drive from one section to the next.

5 Preferably the dowels are made slightly oversize in relation to the recesses which are to accommodate them to ensure that they will fit tightly in the recesses and will transmit the drive without any play. Moreover, the tight fit substantially reduces the risk of dowels coming adrift.

10 Preferably, the dowels are inserted in radial holes bored in the cylindrical or frusto-conical portion of the sections. The dowels may have heads on their inner ends so that centrifugal forces will not tend to dislodge them.

15 The invention may be performed in various ways and one form of rotor embodying the invention, for the axial flow compressor of an aircraft power unit, will now be described by way of example.

20 The rotor is in the form of a cylindrical drum with the rotor blades mounted around the peripheries of annular flanges extending from the cylindrical drum, the external diameters of these flanges increasing progressively from the inlet end of the rotor towards the outlet end.

The rotor is built up from a plurality of sections. Each section has a cylindrical portion adapted to abut against the cylindrical portions of the adjacent sections on each side to constitute the cylindrical drum. Extending radially outwards from the centre of the cylindrical portion of each section is one of the said flanges. The outer periphery of each flange is thickened in the axial direction and is provided with "fir-tree" grooves to receive the roots of the rotor blades which are to be mounted on this section. The two end sections of the rotor are of somewhat different form, having dished flanges and being provided with cylindrical extensions which carry the inner races of bearings upon which the rotor is mounted. The extension at the outlet end of the rotor is provided with a splined formation adapted for connection to a quill shaft leading to the turbine which drives the compressor. The end sections of the rotor may also carry air and oil seal devices in the conventional manner. A light tube extends through the centre of the rotor between the two end sections for a purpose to be described.

The cylindrical portions of the sections have

flat end faces lying in parallel planes perpendicular to the rotor axis, and which abut against the adjacent end faces of the adjacent sections when the rotor is assembled. Radial bores are formed through the cylindrical sections such that half of each bore lies in one section and the opposite half lies in the adjacent section, that is to say, the plane of the abutting end faces of adjacent sections bisect the bores on a diameter. Cylindrical dowels are inserted in these bores, the dowels having heads at their inner ends. These heads are provided with diametral slots, and circlips are inserted into the hollow interior of the rotor to engage the slots in the heads of the dowels to hold the dowels against movement towards the central axis of the rotor.

To form the said bores the sections are assembled together in a jig and the bores are drilled with a radial drill and reamed. The diameter of the bores is slightly smaller than the diameter of the dowels. The rotor is then dismantled and reassembled with the dowels in the bores. Owing to the dowels being slightly oversize, the end faces of the sections will be separated by slight gaps. The central tube previously referred to is then inserted hot and is tightened. As it cools it shrinks and draws the two end sections closer together, thereby closing the said gaps and somewhat distorting the dowels and adjacent portions of the sections to ensure that the dowels are a tight fit.

The spaces between the flanges and the outer surface of the cylindrical drum portion of the rotor are blanked off from the main flow passage of the compressor by thin metal spring rings which are engaged between the platform portions of the rotor blades in adjacent blade rings, the said platform portions lying between the aerofoil portions of the blades and the "fir-tree" root portions.

These spring rings may be dispensed with where the stator blade ring between two rotor blade rings is of shrouded form, that is to say if it has an annular member attached to the tips of the stator blades, since this annular member will also serve to blank off the said spaces from the main flow passage.

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COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of  
the Original on a reduced scale.

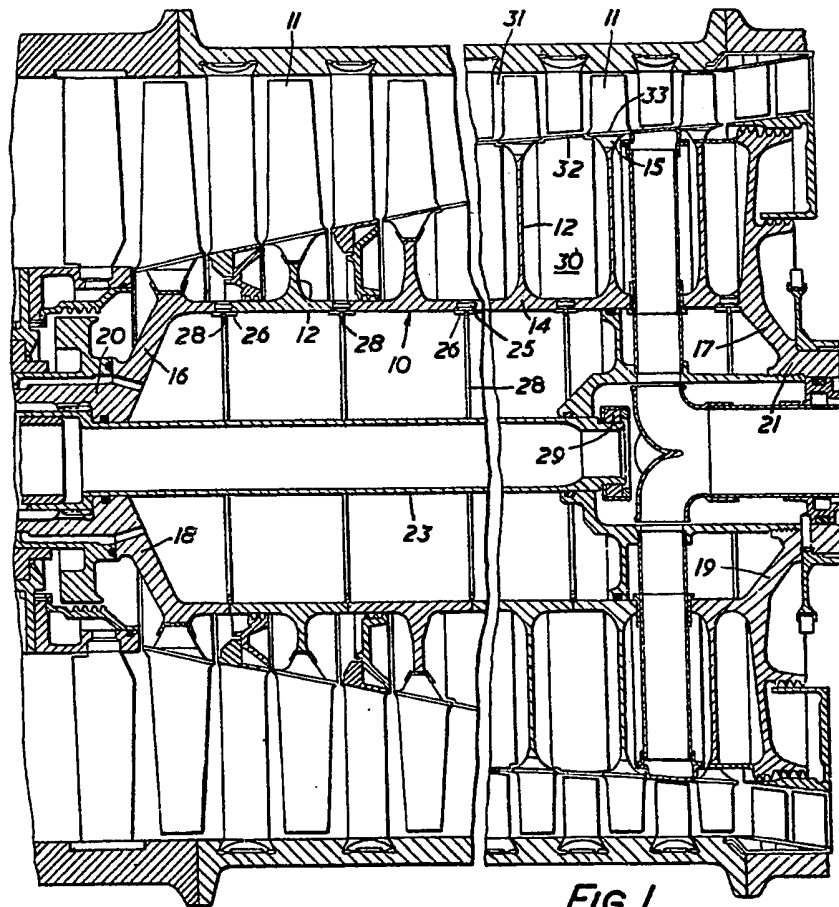


FIG. 1.

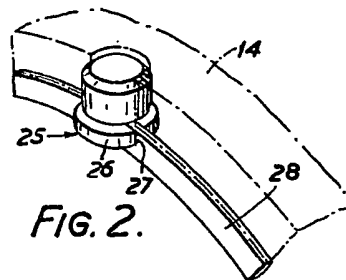


FIG. 2.